XXVI. *On the Structure and Use of the Ligamentum Rotundum Uteri, with some observations upon the change which takes place in the Structure of the Uterus during Utero-gestation.* *By* G. RAINEY, *M.R.C.S., Demonstrator of Anatomy at St. Thomas's Hospital.* *Communicated by* JOSEPH HENRY GREEN, *Esq., F.R.S.*

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PRIOR to the discovery of the striated character of voluntary muscle, about 1765, by FONTANA, physiologists were unacquainted with any certain mark by which they could distinguish this variety of muscle from many other structures; and physiology being at that period in advance of anatomy, the question of the muscularity of many parts was obliged to be decided by their function instead of by their structure; but in the present state of minute anatomy, improved as it has been of late by the researches of microscopists, physiology and anatomy are made to move more in parallelism; this is especially the case with respect to the muscular system, so that if a muscle be made up of a bundle of fascicles of nearly equal size, and each one be marked transversely with parallel striæ, it is known to act either directly in obedience to the will, or to be capable of being called into operation through excito-motory influence, whilst a muscle consisting merely of an aggregation of fibres more or less distinctly nucleated, is known to act independently of the will; hence muscles are now named according to their function, voluntary and involuntary; or according to their structure, striped and unstriped. In the class of striped muscles physiologists are agreed to place the voluntary muscles, the upper part of the human œsophagus, and the heart; in that of unstriped ones, the muscular coat of the intestinal canal, the bladder, the uterus and round ligaments. As it respects the parts included in the latter division of this classification, I am obliged to dissent altogether in reference to the structure of the round ligaments of the uterus, having found in every subject in which I have examined them (the number being about a dozen) well-marked muscular fibres of the striped variety, in fact that they correspond in all respects to regular voluntary muscles: with this conviction I am desirous to communicate the result of my observations to the Royal Society. I may also add, that I have in my possession numerous preparations, microscopic as well as ordinary dissections, in which the accuracy of the facts stated in this paper are easily demonstrable.

The so-called round ligament of the uterus, regarded as a muscle, may be said to arise by three fasciculi of tendinous fibres; the inner one from the tendon of the internal oblique and transversalis near to the symphysis pubis, the middle one from the superior column of the external abdominal ring near to its upper part, and the

external fasciculus from the inferior column of the ring just above GIMBERNAT's ligament; from these attachments the fibres pass backwards and outwards, soon becoming fleshy; they then unite into a rounded cord, which crosses in front of the epigastric artery and behind the lower border of the internal oblique and transversalis muscles, from which it is separated by a thin fascia continuous with the fascia transversalis; it then gets between the layers of peritoneum forming the broad ligament of the uterus, along which it passes backwards, downwards, and inwards to the anterior and superior part of the uterus, into which its fibres, after spreading out a little, may be said to be inserted.

The striated muscular fibres are not confined merely to the surface of the round ligament, as if only accessory to some more important part of it, but they form almost the whole of its substance, and are more particularly distinct near to its centre; nor do they extend completely to the uterus, but after passing between the layers of the broad ligament to about the distance of an inch or an inch and a half from its superior part, they gradually lose their striated character, and degenerate into fasciculi of granular fibres mixed with long threads of fibro-cellular tissue. Plate XXXIX. fig. 1 is an accurate representation of some muscular fibres taken from the centre of the round ligament, where it is situated between the layers of the broad ligament, about one inch and a half from the uterus. Fig. 2 is also a representation of some muscular fibres taken from a part rather nearer to the uterus, showing the manner in which the striped muscular fibre terminates in the granular fibres above mentioned. This structure of the round ligaments is not, as might be expected, confined to the human species. In the Monkey these ligaments are composed almost entirely of striped muscular fibre, which extends all along them nearly as far as the uterus. The uterus in a monkey which I examined was very small, but the round ligaments were proportionally large: the primary fasciculi of muscular fibres were pale but very distinctly striated. In the Dog, as most probably in other animals in which the uterus divides into cornua extending into the abdomen considerably beyond the brim of the pelvis, the round ligaments, instead of passing downwards to be attached to the pelvis, as they are in the human subject, in whom the uterus is situated below its brim, pass from the extremities of the cornua of the uterus upwards, or rather forwards to the last rib. Hence in these instances, these ligaments, or rather muscles, may be said to arise from the last rib, and from the aponeurosis of the diaphragm, by a thin triangular expansion, partly tendinous, and partly muscular (the fibres of the muscle being pale but of the striped kind), and to be inserted into the cornua of the uterus, having the same relation to the Fallopian tubes and ligaments of the ovaries as in the animals which have a simple uterus. In the Sheep and the Cow the attachments of the round ligaments are similar to those in the Dog, and composed likewise of muscular fibres distinctly striated. Besides striped muscular fibres these ligaments contain numerous vessels, also some nerves and absorbents. The arterial trunks are large, but the capillaries into which they ultimately divide have the same size and arrangement as

those of ordinary muscle. The lymphatics are situated on the outer side of the ligament; their glands are sometimes of considerable length, and even pass through the external abdominal ring; connecting all these parts together, there is a considerable quantity of areolar tissue, especially where the striated muscular fibres are absent, or are about to terminate. In this part the detection of these fibres will be facilitated by examining the part in glycerine, which renders the fibro-cellular tissue more transparent without impairing in any considerable degree the distinctness of the striated muscle*. It is generally said that the round ligament passes through the external abdominal ring, and "is LOST in the cellular tissue of the mons veneris and labia pudendi." It is true that the vessels supplying it, and a nerve, and some lymphatics, and frequently a gland, pass through the external abdominal ring, but the substance of the ligament is situated altogether above it so as in part to close it, and thus to tend very much to prevent the protrusion of intestine at this part, whilst it would facilitate its passage through the crural ring by directing it towards GIMBERNAT'S ligament; hence probably the reason why females are more liable to femoral than to inguinal hernia.

Those who have written upon the office of the round ligaments of the uterus, regarding them either as made up of muscular fibres of the same kind as those of the uterus itself, or considering them as composed merely of "condensed cellular tissue," have considered their office, either as subservient to the process of utero-gestation, or as acting merely as mechanical supports to the uterus, that is, as uterine suspensory ligaments. Now the presence of voluntary (striped) muscular fibre in these so-called ligaments, proves that neither of these suppositions is correct, since striped or voluntary muscular fibre would be as unfit for the one purpose as it would be superfluous for the other; hence there can be but little doubt that these ligaments, or rather muscles, are concerned in some way or other with the act of copulation, rather than with those changes which are so slowly induced in the uterus during utero-gestation. Considering the position of the points of attachment of the round ligaments,

* Besides the structures just mentioned, these fibres are mixed with several pale, and much less distinctly striated ones, which resemble in all respects the tissue of the Dartos. The fibres of the Dartos are generally considered merely as fibro-cellular tissue, but they seem to possess characters by which they can be distinguished from other tissues. These fibres, both from the scrotum and the round ligament, the upper part especially, when examined by the microscope in water, appear to be made up of very fine threads of wavy fibre, mixed with extremely minute granules or molecules, by which their distinctness of outline is much obscured and rendered much less apparent than in the fibres of common areolar tissue; they are also more collected into bundles than is fibro-cellular tissue; but these same fibres, when examined in glycerine, become corrugated, resembling somewhat striped muscle; in some instances, indeed, the resemblance is so great, that it is difficult, if not impracticable, to distinguish between a bad specimen of striped muscular fibre and a good one of this tissue. Common fibro-cellular tissue is not corrugated by glycerine, but only rendered more transparent.

The distance to which the striped fibre extends towards the uterus, and the degree of its distinctness, differ very much in different subjects; in one subject I found it not more than an inch from the uterus. In the employment of glycerine to aid the detection of striped muscle and the corrugated tissue, it is sometimes necessary to allow these structures to remain in the glycerine a few minutes before its full effect is produced.

and the direction of their fibres, it is evident that their combined action will bring the uterus nearer to the symphysis pubis, and thus tend to draw it somewhat from the vagina, in this way increasing the length of the latter. Now the only way in which I can imagine that these changes in the position of these parts assist in sexual intercourse, is by their causing the semen to be attracted more into the upper part of the vagina and vicinity of the os uteri. [Since the communication of this paper to the Royal Society I have been informed that this opinion is not new, but that this view of the use of the round ligament had been published by M. Velpeau*, and that it is also partly in accordance with that of Maygriers†.] This supposition seems to accord with the position and attachments of the round ligaments in those animals in which the uterus extends into the cavity of the abdomen beyond the brim of the pelvis, as was noticed in the Dog, the Sheep and the Cow, where their action would, obviously, be the same in drawing the uterus from the vagina, and in tending to elongate the latter, as in the human subject in whom the angles of the uterus are below the level of the broad ligaments. In such an act the muscular fibres of the round ligaments could scarcely be said to be voluntary; but still they would be as much so as the other muscles concerned in the same process, that is, as those of the male organs of generation. In these instances muscles are said to act under excito-motory influence, but muscles which are thus excited have the same structure as those more obviously under the control of the will, namely, striped fibres.

Some observations upon the change which takes place in the Structure of the Uterus during Utero-gestation.

The fasciculi of fibres composing the upper part of the round ligament separate as they approach the fundus of the uterus, become spread out over its surface, and ultimately blend with its fibres. Although the fibres of the round ligament are generally said to be of the same kind as those of the uterus, I have not been able to perceive much similarity, either with those of the unimpregnated or the impregnated uterus, the fibres in both these states of the uterus being peculiar. The proper tissue of the unimpregnated uterus is so remarkably dense that there is considerable difficulty in unraveling it sufficiently to display the true character of its fibres, and sections thin enough to admit of being seen as a transparent object by the microscope, give no distinct idea of its real nature. Its characters can be best understood by breaking up portions of the uterus with needles, and examining them in glycerine, but still they should be first seen in water; also the arteries of the uterus should be fully injected (these are remarkably tortuous, and possessed of very thick coats), otherwise the tissue of the small vessels, and the nuclei in the coat of the capillaries, may be examined instead of, and mistaken for, the proper fibre of the uterus. Any part of the unimpregnated uterus, after having been thus treated, will be seen to be made up

* Anatomie Chirurgicale, 1833, vol. ii. p. 372.

† Nouvelles Démonstrations d'Accouchements, p. 62.

of fusiform nucleated fibres, contained in a matrix of exceedingly coherent granular matter; these are well represented in fig. 3. The average breadth of one of these fibres, at its dilated or nucleated part, is about $\frac{1}{4000}$th of an inch; their length cannot be ascertained with certainty, as it is impossible to estimate the degree of curtailment which they suffer in being separated from the granular matrix in which they lie imbedded. Their structure and size are about the same in every part of the uterus from which I have taken them, so that they are easily recognizable as the peculiar fibres of the unimpregnated uterus. Now comparing these fibres with those forming the walls of the impregnated one, at the full, or at a very advanced period of impregnation, it will be seen that these fibres are become greatly increased in size, deprived of nuclei, and more loosely connected together; they lie in separate planes, which cross each other in various directions; they are accompanied with vessels of various sizes, also with more or less fibro-cellular tissue. The size of these fibres is moderately uniform, but those near to the external surface are rather smaller than those more deeply seated. A fibre detached from the rest measured about $\frac{1}{40}$th of an inch in length and about $\frac{1}{2000}$th in breadth at its widest part; for the breadth varies much in different parts of the same fibre, being alternately large and small; at their extremities they taper off to a very fine point; their colour is yellowish, and when minutely examined, they appear to be made up of very small irregular granules and extremely slender threads blended together without any definite arrangement (see fig. 4). Acted upon by acetic acid they give no indication whatever of being nucleated, therefore in this respect they differ from the common form of organic muscular fibre*. The two kinds of fibres, represented in figs. 3 and 4, were both drawn under the same magnifying power, in order to show, by a comparison of their dimensions, that the increase which takes place in the individual fibres in these different states of the uterus, is quite sufficient to account for the amount of augmentation of the entire organ, without supposing, as some physiologists do, that organic muscular fibres, not present in the inactive state of the uterus, are absolutely formed during the various stages of its enlargement; it also, besides being supported by the fact just stated, perfectly accords with the laws of development, and harmonizes with the changes which are going on simultaneously in the walls of the impregnated uterus and its contents; the unimpregnated uterus being, according to this notion, little more than an assemblage of embryonic nucleated fibres, wholly inactive, until after the reception of the ovum, when, being aroused by an appropriate stimulus, they are called into active operation, and become developed simultaneously and proportionally to the development of the fœtus contained within it, so that when the one has arrived at a state requiring to be expelled, the other has acquired the utmost degree of fitness necessary to effect its expulsion. Now after the expulsion of the fœtus, since, according to the laws of de-

* Professor Kölliker has described the fibres both of the unimpregnated and impregnated uterus. The latter he has described and figured as having nuclei, which I have never been able to verify although I have examined these fibres with the greatest possible care.

velopment, it is as impossible that these fibres of the impregnated uterus can retur n again to their primitive or embryonic condition, as that a full-formed fœtus could relapse into the state of an ovum, they must necessarily become absorbed, and therefore a new set of embryonic fibres would require to be formed for the expulsion of the next ovum, so that each fœtus will have, according to this conclusion, its own peculiar expulsory fibres. This view is perfectly in accordance with the late researches of Drs. SHARPEY and WEBER on the membrana decidua; and it agrees with the same function in vegetables, in which the part corresponding to the uterus in animals is always cast off after its contents have been brought to maturity, and separated from the parent plant.

DESCRIPTION OF THE PLATE.

PLATE XXXIX.

Fig. 1. Represents some muscular fibres taken from the central part of the round ligament of the uterus of the human subject, where it is situated between the layers of the broad ligament.

Fig. 2. Represents some muscular fibres taken from a part of the round ligament nearer to the uterus than those shown in fig. 1: there the termination of the striated fibres in fasciculi of granular ones is shown.

Fig. 3. Represents nucleated fibres taken from the unimpregnated human uterus, and the granular matrix in which they are imbedded.

Fig. 4. Represents fibres taken from the impregnated human uterus at the eighth month of pregnancy.

Fig. 1.

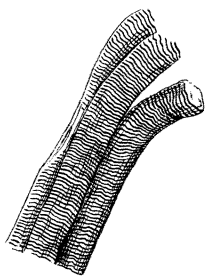

Fig. 2.

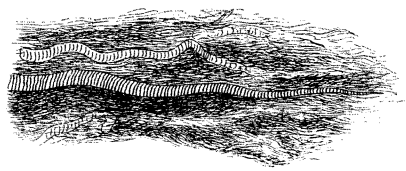

Fig. 3.

Fig. 4.